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MATHÉMATIQUES

PROBLÈME LIMITE FONDAMENTAL POUR LES ÉQUATIONS POLYHARMONIQUES DANS UN DOMAINE AU CONTOUR DÉGÉNÉRÉ

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Dans cet article nous éxaminons l'équation polyharmonique

$$\sum \frac{m!}{\alpha_1!\,\alpha_2!\,\ldots\,\alpha_n!}\,\frac{\partial^{2m}u}{\partial x_1^{2\alpha_1}\partial x_2^{2\alpha_2}\ldots\partial x_n^{2\alpha_n}} \equiv \Delta^m u = 0 \qquad (1)$$

dans l'espace à n dimensions $x_1, x_2, \ldots x_n$. Nous allons supposer dans la suite que $m > \frac{n}{2}$.

Considérons le domaine D dont la frontière S consiste en plusieurs multiplicités d'un nombre quelconque de dimensionsi:

$$S = S_{n-1} + S_{n-2} + \ldots + S_{n-s} + \ldots + S_0. \qquad (2)$$

Nous supposons que chaque multiplicité S_{n-s} est constitué d'un nombre fini des parties dont chacune peut être transformée en un domaine de l'éspace $x_{s+1}, x_{s+2}, \ldots, x_n$:

$$x_1 = x_2 = x_3 \ldots = x_s = 0 \qquad (3)$$

au moyen d'une transformation ponctuelle, ayant les dérivées continues d'ordre assez grand.

Étant donné une fonction φ, définie dans le domaine D, nous allons considérer les intégrales:

$$D_l(\varphi) = \overbrace{\int \ldots \int}^{n}_{D} \sum \frac{l!}{\alpha_1!\,\alpha_2!\,\ldots\,\alpha_n!}\left(\frac{\partial^l \varphi}{\partial x_1^{\alpha_1}\partial x_2^{\alpha_2}\ldots\partial x_n^{\alpha_n}}\right)^2 dx_1\,dx_2\,\ldots\,dx_n. \qquad (4)$$

Désignons par $L_k(A)$ la famille des fonctions φ telles que les intégrales $D_0(\varphi), D_1(\varphi), \ldots, D_k(\varphi)$ sont au plus égales à A.

Soit L_{n-s} une multiplicité à $(n-s)$ dimensions satisfaisant à la condition mentionée plus haut et L'_{n-s} une multiplicité voisine * dont la

* Le sens précis de l'expression «multiplicité voisine» sera détaillé dans le mémoire prochain.

distance de L_{n-s} ne dépasse pas δ. Nous dirons que la fonction φ converge en moyenne vers sa valeur sur L_{n-s}, si l'intégrale

$$I_{L_{n-s}} = \frac{1}{L_{n-s}} \overbrace{\int \cdots \int}^{n-s}_{L_{n-s}} (\varphi|_{L'_{n-s}} - \varphi|_{L_{n-s}})^2 \, dL_{n-s} \tag{5}$$

tend vers zéro avec δ. Si pour une famille quelconque des fonctions cette intégrale tend vers zéro d'une façon indépendante du choix de la fonction φ, nous dirons que la famille considérée est également continue en moyenne sur L_{n-s}.

Une simple généralisation de quelques évaluations que uous avons obtenu antérieurement (1) permet d'énoncer les deux lemmes suivants:

1) Soit L_{n-s} la multiplicité en question. L'intégrale

$$\frac{1}{L_{n-s}} \overbrace{\int \cdots \int}^{n-s}_{L_{n-s}} (\varphi|_{L_{n-s}})^2 \, dL_{n-s} \tag{6}$$

est uniformément borné pour toutes les fonctions de la familles $L_{\left[\frac{s}{2}\right]+1}(A)$.

2) La famille $L_{\left[\frac{s}{2}\right]+1}(A)$ est également continue en moyenne sur L_{n-s} et de plus

$$I_{L_{n-s}} \leqslant \begin{cases} C\delta^2 \lg \delta, & \text{si } s \text{ est un nombre paire,} \\ C\delta, & \text{si } s \text{ est un nombre impaire,} \end{cases} \tag{7}$$

où C est une constante indépendante de φ.

Ces deux lemmes permettent de démontrer le théorème suivant.

Théorème I. *Chaque solution de l'équation* (1) *pour laquelle existe l'intégrale* $D_m(u)$, *atteint sur la partie* S_{n-s} *du contour avec toutes ses dérivées jusqu'à l'ordre* $m - \left[\frac{s}{2}\right] - 1$ *des valeurs à carré intégrable sur* S_{n-s}. *Chacune de ces dérivées converge en moyenne vers sa valeur limite. Le caractère de cette convergence est défini par une inégalité du type* (7).

Nous appellerons problème limite fondamental pour l'équation (1) le problème de la détermination de la fonction u dans le domaine D, les valeurs de la fonction et de toutes ses dérivées jusqu'à l'ordre $m - \left[\frac{s}{2}\right] - 1$ sur chaque multiplicité S_{n-s} étant donné:

$$u|_{S_{n-s}} = \psi_{0\,0\,\ldots\,0}; \ \ldots; \ \left.\frac{\partial^\alpha u}{\partial x_1^{\alpha_1} \partial x_2^{\alpha_2} \ldots \partial x_n^{\alpha_n}}\right|_{S_{n-s}} =$$

$$= \psi_{\alpha_1 \alpha_2 \ldots \alpha_n}; \ \ldots; \ \left.\frac{\partial^{m-\left[\frac{s}{2}\right]-1} u}{\partial x_n^{m-\left[\frac{s}{2}\right]-1}}\right|_{S_{n-s}} = \psi_{0\,0\,\ldots\,m-\left[\frac{s}{2}\right]-1}. \tag{8}$$

On suppose que la fonction u et ses dérivées tendent en moyenne vers leurs valeurs limites. Le théorème suivant a lieu.

Théorème II. *Dans le cas où les fonctions* ψ *dans les parties droites de* (8) *sont telles qu'il y a au moins une fonction* $\bar{u}$ *satisfaisant aux conditions* (8) *pour laquelle l'intégrale* $D_m(\bar{u})$ *existe, — le problème limite fondamental admet une solution. Cette solution est donnée par la*

fonction u pour laquelle l'intégrale $D_m(u)$ atteint sont minimum par rapport à la famille de toutes les fonctions satisfaisant aux conditions (8).

La démonstration est fondé sur le même principe que la démonstration de Friedrichs (2) de l'existence d'une solution de l'équation biharmonique à deux variables indépendantes. Il suffit de construire une suite minimale u_i pour l'intégrale $D_m(u)$. On peut démontrer qu'une telle suite converge uniformément vers une fonction limite u qui donne la solution du problème en question.

Nous allons indiquer encore un théorème important.

Théorème III. *La solution du problème limite fondamental de l'équation* (1) *pour laquelle l'intégrale $D_m(u)$ existe est unique.*

Pour la démonstration il suffit d'établir, que dans le cas ou toutes les fonctions ψ s'annulent, la solution du problème fondamental s'évanoui nécéssairement.

Soit φ cette solution.

Désignons par

$$\int_{S_\eta}^{S_\zeta} \cdots \int \psi dx_1 \ldots dx_n$$

l'intégrale étendue au domaine qui est formée de tous les points dont la distance δ du contour s satisfait à l'inégalité:

$$\eta < \delta < \zeta.$$

En se servant de l'intégration par parties on peut établir l'inégalité:

$$D_m(\varphi) \leqslant \lim_{h\to 0} \frac{C}{h} \int_{S_{2h}}^{S_{3h}} \cdots \int \sum_{\substack{\alpha_1+\alpha_2+\ldots+\alpha_n=l,\\ \beta_1+\beta_2+\ldots+\beta_n=t.}} \frac{\partial^l \varphi}{\partial x_1^{\alpha_1} \partial x_2^{\alpha_2} \ldots \partial x_n^{\alpha_n}} \frac{\partial^t \varphi}{\partial x_1^{\beta_1} \partial x_2^{\beta_2} \ldots \partial x_n^{\beta_n}} dx_1 dx_2 \ldots dx_n. \quad (9)$$

$$t + l = 2m - 1.$$

En tenant compte de ce que la valeur de chaque fonction polyharmonique au centre d'une sphère de rayon h s'exprime au moyen des valeurs de la fonction à l'intérieur de cette sphère par la formule suivante:

$$\varphi(x_1, x_2, \ldots, x_n) =$$

$$= \frac{1}{h^n} \overbrace{\int \cdots \int}^{n} K\left(\frac{x_1 - x_1'}{h}, \ldots, \frac{x_n - x_n'}{h}\right) \varphi(x_1', \ldots, x_n') dx_1' \ldots dx'_n, \quad (10)$$

où le noyau K est dérivable une infinité de fois, et en se rappelant de l'inégalité de Schwarz, on peut tirer de l'inégalité (9) la formule suivante:

$$[D_m(\varphi)]^2 \leqslant$$

$$\leqslant \lim_{h\to 0} \frac{C}{h^{2m}} \int_{S_h}^{S_{4h}} \cdots \int \varphi^2 dx_1 \ldots dx_n \int_{S_h}^{S_{4h}} \cdots \int \sum \frac{m!}{\alpha_1! \alpha_2! \ldots \alpha_n!} \left(\frac{\partial^m \varphi}{\partial x_1^{\alpha_1} \ldots \partial x_n^{\alpha_n}}\right) dx_1 \ldots dx_n \quad (11)$$

En évaluant le premier facteur de la partie droite à l'aide des inégalités (7) et des formules exprimant la fonction φ au moyen de ses dérivées nous aurons:

$$\int_{S_h}^{S_{4h}} \cdots \int \varphi^2 dx_1 \ldots dx_n \leqslant K h^{2m} |\lg h| . \tag{12}$$

Il s'ensuit de l'existence de l'intégrale $D_m(\varphi)$ que quelle que soit la constante A on peut déterminer une suite de nombres h tendant vers zéro telle que

$$\int_{S_h}^{S_{4h}} \cdots \int \sum \frac{m!}{\alpha_1! \ldots \alpha_n!} \left(\frac{\partial^m \varphi}{\partial x_1^{\alpha_1} \partial x_2^{\alpha_2} \ldots \partial x_n^{\alpha_n}} \right)^2 dx_1 \ldots dx_n \leqslant \frac{A}{|\lg n| \lg |\lg h|} . \tag{13}$$

Il en résulte que $D_m(\varphi) = 0$. Mais alors la fonction φ étant un polynôme de degré $(m-1)$ doit s'annuler grâce à (8). Cette remarque achève la démonstration.

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PHYSICAL CHEMISTRY

THE ROLE OF THE SOLID PHASE IN THE IGNITION OF COMBUSTIBLE MIXTURES

By M. POLJAKOV and K. GRJANENKO

(Communicated by L. W. Pissarjewsky, Member of the Academy, 21. V. 1936)

The fact that the ignition of combustible mixtures greatly depends, not only on the temperature, pressure, composition and nature of these mixtures, but also on the diameter and shape of the vessel wherein the ignition takes place, is well known. Particularly interesting is the role of the solid phase in thermal ignition (explosion), because herein lies the possibility of discovering the explosion constants and of obtaining a complete knowledge of both catalytical and explosion processes, this fact being of great importance for heterogeneous catalysis, in general, and for the catalysis of exothermic reactions, in particular.

Using in our laboratory the method of fixation of intermediate products, we have fully demonstrated the connection existing between the surface and volume processes in the form of the heterogeneous-homogeneous catalysis. The results obtained in the case of H_2+O_2 were fully confirmed for CH_4+O_2 and $C_2H_2+O_2$ mixtures. Evidently, we had to deal with a general phenomenon: as a result of the propagation of the reaction throughout the volume by a chain process the catalytical surface process takes place also outside the catalyst.

This process takes place in the form of an explosion when the concentration of initial centres, the pressure, temperature, etc. reach certain critical values.

The facts established are of great use in solving many problems connected with the kinetics and the mechanism of explosion, because, obviously, the limit concentration of initial centres is reached with an active participation of the surface process, which propagates these centres into the volume.

Since the method usually employed by the investigators of explosion reactions does not give a one-valued solution for a number of problems connected with the role of the surface in the origination of an explosion, it was of particular interest for us to use this method with a view to confirming our results and conclusions obtained by another method. This was what prompted us to undertake the work some results of which are set forth below.

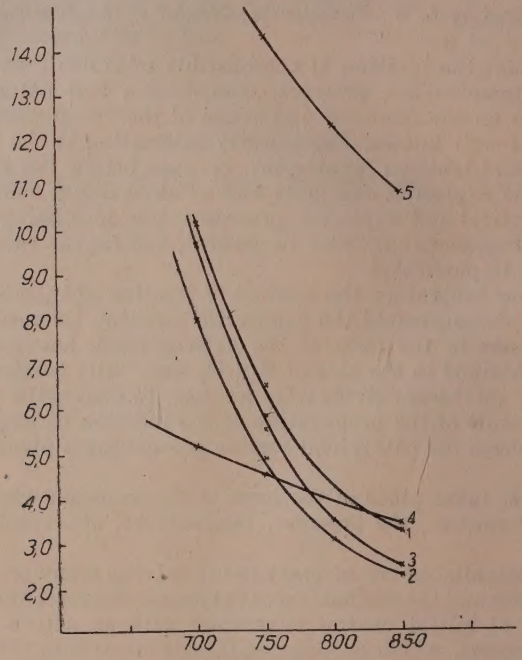
Some investigators, trying to solve the above-mentioned problem, used to put different metals in the form of wire, foil, etc. into the reaction vessel;

we did the same, with the difference that we varied the surface of the metal introduced into the vessel.

As a basis for judging of the action of Pt of different surfaces, we chose the following well-known explosion constants: the lower limit and the induction period. The mixture investigated was methane + oxygen. The catalyst used was a platinum wire. Without describing the methods used (this being done in detail in another article), we shall set forth some of the results obtained.

Table of the Inferior Limits ($P_н$) in cm Hg

	850° C	800° C	750° C	700 °C
Without Pt	3.3	3.5	4.8	5.2
1.5 cm. »	2.3	3	4.5	8.0
3 » »	2.4	3.5	5.3	9.8
5 » »	3.2	4.8	5.6	10.2
20 » »	10.7	12.2	14.2	—



1—without Pt
2—Pt in 1.5 cm
3— » » 3 »
4— » » 5 »
5— » » 20 »

The table and the diagram show the dependence of the lower limit of the explosion on temperature in the absence of Pt and in its presence in the form of a wire 1.5, 3,5, 20 cm long.

From this diagram the following may be inferred:

1) The flash limit (P_k) rises with an increase in the length and, therefore, the surface of Pt.

2) At temperatures higher than 750°, Pt with a small surface leads to the lowering of the explosion limit (also of the induction period, as will be seen from our next communication).

It is interesting to note that we expected P_k to decrease at exactly those conditions which were observed in the experiment.

An analysis of the diagram justifies some conclusions, of which we shall mention the following:

1) The fact that a decrease of P_k is observed to occur exactly when the specific weight of the platinum surface is small and this surface occupies only a small part of the reaction vessel (a quartz tube 10×3 cm), proves that, in this case, the propagation of active centres throughout the volume predominates over their recombination on the Pt surface, because the probability of their getting to the surface from distant parts of the reaction vessel is smaller than the probability of their propagation throughout the vessel.

If, on the other hand, Pt is uniformly distributed throughout the vessel (20 cm long), we must have another result, which is really the case; therefore, it appears that Pt really propagates active centres which induce explosion when they reach a critical value.

2) The fact that the decrease of P_k takes place at high temperatures needs no comment; of course, at high temperatures the propagation of the reaction throughout the volume must be especially easy.

Further work on the problem is being done.

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CHEMISTRY

THE SOLUBILITY AND ACTIVITY OF THE HALOGENATES OF SOME BIVALENT METALS

III. THE SOLUBILITY AND ACTIVITY OF $Ra(IO_3)_2$ IN WATER AND IN SOLUTIONS OF ELECTROLYTES

By A. POLESICKIJ and P. TOLMAČEV

(Communicated by V. I. Vernadskij, Member of the Academy, 9. VI. 1936)

The solubility of radium salts has been studied very little. Lind, Underwood and Whitemoore (1) determined the solubility of $RaSO_4$ in water and in solutions of H_2SO_4 and Na_2SO_4, but their results were wrong. These results were corrected by Erbacher and Nikitin (2) and later by Nikitin and Tolmačev (3). Besides that, Erbacher (4) determined the solubility of $BaBr_2$, $RaCl_2$, and $Ra(NO_3)_2$ in water at 20 C.

Method

A small sample of 99% $RaCl_2$ (20—60 mg) was dissolved in 2—3 cm^3 of water and treated with an exactly equivalent amount of recristallized solid KIO_3. The precipitate was washed 3—4 times by decantation with small amounts of water or, for determination of solubility in solutions of electrolytes, with the corresponding solutions. The salt with the remainder of the decanting liquid was transferred to the flask used for solubility determinations.

The solubility was determined by the same methods as those described for $Ba(IO_3)_2$ and $Pb(IO_3)_2$ (5), the only difference being that the flasks used were of much smaller dimensions.

In the samples, radium content was determined. For this purpose samples of solutions in water and in KNO_3 and $Ca(NO_3)_2$ were evaporated in glass tubes, sealed up and measured by the γ-ray method with a Hess electrometer. The radium content in KIO_3 solutions, where the solubility was very small, was determined by the ordinary «emanation» method.

Results

The solubility of $Ra(IO_3)_2$ in water at different temperatures is shown in Table 1 and in Fig. 1.

Table 1

Solubility of $Ra(IO_3)_2$ in Water

T°	mg/l	mol/l
0°	176	0.000305
25°	437	0.000760
78°	1244	0.00216
100°	1705	0.00296

The solubility of $Ra(IO_3)_2$ in solutions of KNO_3, $Ca(NO_3)_2$ and KIO_3 at 25° C is shown in Table 2 and, for KNO_3 and $Ca(NO_3)_2$ solutions, also in Fig. 2, where the solubility is plotted against the total ionic strength of the solution. The extrapolation of this curve to the zero ionic strength gives the limiting solubility of $Ra(IO_3)_2$. For 25°C it is equal to 0.432 g/l.

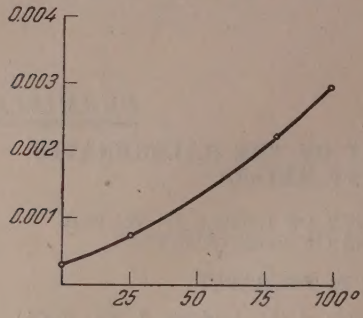

Fig. 1.

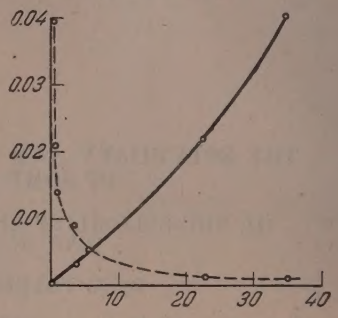

Fig. 2.

The dotted curve in Fig. 2. gives the activity coefficients of $Ra(IO_3)_2$ at different ionic strength calculated from the ration of the solubility in the given solution to the limiting solubility.

Table 2

Solubility of $Ra(IO_3)_2$ in Solutions of Electrolytes at 25°

Electrolyte	Concentration mol/l	Solubility of $Ra(IO_3)_2$		Total ionic strength	Activity coefficient
		mg/l	mol/l		
H_2O	—	0.437	0.000760	0.00456	0.988
KNO_3	1.85	1.904	0.00331	3.725	0.227
	2.05	3.506	0.00530	5.035	0.141
$Ca(NO_3)_2$	3.80	12.71	0.0221	22.932	0.034
	5.85	23.41	0.0406	35.345	0.0185
KIO_3	0.08	$1.09 \cdot 10^{-3}$	$1.90 \cdot 10^{-6}$	0.160	0.531
	0.35	$0.218 \cdot 10^{-3}$	$0.379 \cdot 10^{-6}$	0.350	0.344

Summary

1. The solubility of $Ra(IO_3)_2$ in water at different temperatures has been determined.

2. The solubility of $Ra(JO_3)_2$ in concentrated solutions of KNO_3, $Ca(NO_3)_2$, and KIO_3 at 25° C has been determined at different concentrations of the electrolytes.

3. The limiting solubility of $Ra(IO_3)_2$ and the activity coefficients at different ionic strength have been calculated.

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GEOCHEMISTRY

THE SPECTRAL ANALYSIS OF MINERAL WATERS

By M. T. LINDTROP and J. M. TOLMAČEV

(Communicated by D. S. Roždestvenskij, Member of the Academy, 20. VI. 1936)

Bunsen and Kirchhoff (1) were the first to apply spectral analysis to the investigation of mineral waters and their precipitates; they discovered the elements rubidium and caesium, unknown before, in mineral waters. Bunsen, Grandeau, Böttger and others (2) have determined since then Rb and Cs in various French and German mineral waters. Among recent investigations, Pereira-Forjaz's (3) qualitative spectral analysis of the Gerez mineral water and of the slightly mineralized and strongly radioctive water from Cambres (Portugal) may be mentoned. Besides the elements detected chemically, Ge, Ag, Pb and Cs were found in hte first water with the aid of spectral analysis. In the second water, besides Li, Sr, Ba, Al, Mn and Ti, found by chemical methods, Ra, Pb, U and V were detected with the aid of spectral analysis; the presence of Zn, Cu, Ge and Tl seemed to be very probable, although it could not be definitively ascertained. Fresenius (4) has made parallel chemical and spectral determinations of Rb and Cs in Dürheim mineral water (Germany). Gazzi (5) has investigated a series of the dry precipitates of mineral waters, using the infra-red lines of Rb and Cs. A large number of mineral waters was subjected to spectral analysis by Bossuet (6), who investigated them for the presence of Li, Rb and Cs. Li and Rb were found in all the 180 waters analysed by him; Cs was not detected in 43 waters. On the basis of these data, Bossuet draws some conclusions concerning the genesis of the sources of mineral waters, assuming that the absence of Cs characterizes the superficial waters, and its presence, the rock waters.

The mineral waters of the USSR were also subjected to spectral analysis. Orlov (7) has investigated the water from Tzaritzinski Source in Staraya Russa and has detected Rb and Cs in it. V. Vernadsky(8) has analysed a series of Caucasian mineral waters and their precipitates for the presence of Li, Rb, Cs, TI, In, and other elements. The investigation, qualitative in nature, was performed visually; oxy-gaseous flame was used. The author notes that «it was for the first time that caesium was detected in the precipitates of Caucasian mineral waters; in the waters themselves, however, its presence could not yet be fixed with certitude. Rb, together with Cs, was detected also in

saltpetre (KNO_3) near Kislovodsk and in the precipitates of Caucasian mineral waters; Rb was found also in the water of the Piatigorsk Mineral Source in «Emmanuel Park».

These data show that Li and Rb are more common in mineral waters than Cs. Our investigation was undertaken for the purpose of carrying out a quantitative analysis of Caucasian mineral waters for the presence of rare elements (Li, Rb, and Cs). We have chosen for this purpose the waters representing the four groups of Caucasian mineral waters:

1) Warm Narzan, Piatigorsk;
2) Slavianovski Source, Zheleznovodsk;
3) Source N 17, Yessentuki;
4) Dolomite Narzan, Kislovodsk,

and the strongly mineralized saline Glauber's salt waters:

5) Batalinski Source;
6) Lysogorsky Source.

For the qualitative and quantitative determinations, compact precipitates of these waters were chiefly used. In some cases of the qualitative determinations of Rb and Cs, we were obliged to resort to concentration, since it was impossible to detect these elements by a direct analysis of the precipitate.

For the quantitative determinations, alcohol extracts, prepared from the compact precipitates, were used. These extracts were obtained by washing 25 times the compact precipitate with alcohol, the salts being preliminarily convereted into chlorides. The alcohol then was removed and the percipitate dissolved in a minimum quantity of water. Qualitative and quantitative determinations of Li, Rb and Cs were performed by means of a spectrograph. The most intense lines were used for the analysis, viz.: 6707.8 Å for Li, 7800.3 Å and 7947. 6 Å for Rb and 8521.1 Å for Cs. Detailed descriptions of the use of these lines in the analysis may be found in the literature ([5],[9],[10]). Qualitative determinations were performed with the aid of an electric arc run at 5—7 Å and 110 V d. c. For the quantitative determinations, a condensed spark fed by a transformer of an intensity of 10 000 V in the secondary winding was used. The oscillatory circuit included a condenser (0.01 mF), a self-induction (whose value was fixed empirically) and a spark gap. The method of comparison spectra was used for the quantitative determinations. A series of standard solutions containing known amounts of Li, Rb, and Cs were prepared. The quantity of Na and Ca in these standard solutions was adjusted to their content in the extracts. Pure Siemens E-Kohle were employed. For taking photographs with the arc, the test-portion was introduced into the bore of the lower carbon, the latter playingthe role of anode. When spark was used, the lower electrode was provided with a spherical cavity into which the solution under investigation was introduced. The length of the exposure was 1—2 min. for the arc; 15 min. for the spark; in this last case, 0.06 cm^3 of the solution was introduced every minute into the lower electrode.

The spectra were taken with a glass Hilger spectrograph (D—$\frac{3}{4}$). Plates of the Photochemical Trust, speed 200 H. D., sensitized with neocyanine were used. They were developed in the pyrogallol-acetone devoloper.

The qualitative analysis has shown that Li and Rb are present in all waters mentioned above. Cs could be detected only in the waters 1, 2 and 4. The results of the quantitative analysis are summarized in Table 1.

Table 1

No	Name and location of the source	Quantity in grams per litre of water	
		Li	Rb
1	Warm Narzan, Piatigorsk	$240 \cdot 10^{-6}$	$12 \cdot 10^{-6}$
2	Slavianovski Source, Zheleznovodsk . .	$140 \cdot 10^{-6}$	$8 \cdot 10^{-6}$
3	Source No. 17, Yessentuki	$220 \cdot 10^{-6}$	$3 \cdot 10^{-6}$
4	Dolomite Narzan, Kislovodsk	$20 \cdot 10^{-6}$	$6 \cdot 10^{-6}$
5	Batalinski Source	$6 \cdot 10^{-6}$	$0.2 \cdot 10^{-6}$
6	Lysogorsky Source	$3 \cdot 10^{-6}$	$0.15 \cdot 10^{-6}$

The attempt at a quantitative determination of Cs in the waters 1, 2 and 4 failed, since the line 8521.1 Å in the spark is much less sensitive than in the arc and since this line was scarcely visible on the plates taken with the arc. A considerable concentration will therefore be necessary to make possible a quantitative determination of Cs in these waters.

The data obtained show that, as regards the content of Li and Rb, the waters from Batalinski and Lysogorsky Sources differ very strongly from other waters. The difference between the groups of water will be made perceptible, if we compare the ratio of the weights Na : Li and K : Rb, as shown in Table 2.

Table 2

No	Name and location of the source	Weight ratio	
		Na : Li	K : Rb
1	Warm Narzan, Piatigorsk	4 000	5 500
2	Slavianovski Source, Zheleznovodsk . .	4 500	4 600
3	Source No 17, Yessentuki	15 600	3 500
4	Dolomite Narzan, Kislovodsk	19 000	4 000
5	Batalinski Source	1 900 000	115 000
6	Lysogorsky Source	1 600 000	135 000

The K and Na content of these waters were determined chemically by Karstens and Larin ([11]).

Table 2 shows that all the waters investigated may be divided into three groups, according to the value of the ratio Na : Li and K : Rb.

Group 1, with the ratio 4000—4500 for Na : Li and 4600—5000 for K : Rb. The Slavianovski Source and the Warm Narzan, having many common features, belong to this group. Both sources are associated with laccolites, the first welling up on the slope of Zheleznaya Mountain, the other on the slope of Mount Mashuk. Their chemical nature is also similar, both being characterized by the predominance of sulphates and lime. A comparison of the Zheleznovodsk waters with the Piatigorsk ones shows that NaCl is present in the latter.

Group 2, with the ratio 15600—19000 for Na : Li and 3500—4000 for K : Rb, the second ratio being somewhat smaller than in the case of Group

1. Dolomite Narzan and Source No 17 belong to this group. Both sources have also many common features. Their springs are not associated with laccolites. Sulphates do not predominate in them, and their chief component is sodium bicarbonate. Dolomite Narzan contains considerable quantities of calcium bicarbonate and differs in this respect from the two other groups.

Group 3, including Batalinski and Lysogorsky Sources, differs strongly from the two other groups. The ratio Na : Li is in this case equal to 1 600 000—1 900 000, while the ratio K : Rb is 115 000—135 000. In comparison with the four other waters, these two are strongly mineralized, their chief components being sulphates of sodium and magnesium. As to their genesis, they belong to more superficial waters and are not saturated with CO_2.

This shows that the value of the ratios Na : Li and K : Rb may be used as a complementary characteristic of the three groups of Caucasian mineral waters mentioned above.

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GEOLOGY

ON THE STRATIGRAPHY OF TRIAS IN KUZNETSK BASIN

By M. F. NEIBURG

(Communicated by A. D. Archangelsky, Member of the Academy, 20. VI. 1936)

Investigations carried out in recent years have made it possible to identify among the coal bearing series of sedimentary deposits in Kuznetsk Basin a number of strata of the Upper Carbon, Permien and Lower Jurassic age (1). As early as 1929, however, the author had found in the greenish clayey shales over the basalts of the section called «Babiy Kamen» located in the central part of the basin on the right bank of the river Tomi, some remains of a fauna of *Pelecypoda* and *Estheria*, as well as imperfectly preserved wing-sheaths of a beetle, which, according to a preliminary determination by A. V. Martynov, pointed to the Lower Jurassic—Upper Triassic age of the enclosing strata*. No definite determination of the *Estheria* was made, as the specimens had been lost by the specialist who had them in charge. In 1930 V. I. Javorsky again collected remains of *Estheria* in the same locality. B. I. Chernyshev (2) determined them as *Estheria minuta* (?) G o l d f. and referred the respective horizons to Upper Trias. V. I. Javorsky(3) therefore thought it possible to mark down in the stratigraphic column of the basin a new series of Triassic age—the Maltzev series—of a minimum thickness of 70 m. The Trias having thus been identified on the basis of a single and rather uncertainly determined form taken from only one horizon of the section, this identification was naturally received with incredulity. Later on V. A. Chachlov became possessed of some data proving, in the opinion of that author, that even the stratigrafically lower horizons of the section belonged to lower Jura.

As a result of a detailed study of «Babiy Kamen» section carried out during the summer of 1935 under instructions from the Geological Institute of the Academy of Sciences, the author succeeded in obtaining materials which embraced the entire section, and actually established the presence of Trias among the coal-bearing strata of the basin.

The Babiy Kamen section extends for about 4 km along the right bank of the Tomi river and is represented by a monocline of sedimentary strata of a north-easterly dip. From the stratigraphical point of view the lower part of the section is composed of normal sandstones, arenacea-argillaceous

* Report of the author in the West-Siberian Section of the Geological Committee, February 14, 1930.

shales with spherosiderites, of marls and thin coal seams and carbonaceous shales, with an abundant fauna of *Pelecypoda* and *Ostracoda* and vegetable remains, and this part of the section may therefore be justifiably classed as Permian.

The complex of rocks classed as Triassic is at least 350 m thick; from the stratigraphic point of view these rocks represent the upper part of the section and are located above the topmost coal layer still belongigng to the lower part of the section. This upper part of Babiy Kamen section, which has been classed as Triassic, differs from the underlying lower part of the section both lithologically and paleontologically.

In this part of the section the Triassic formations are represented by sedimentary rocks (sandstones, clayey shales, marls), the normal habit of which has been greatly altered by a considerable admixture of tuffogenous material. In addition to this it is observed that the rocks are strongly enriched by calcium carbonate and the presence of a large quantity of ceolite. All this, combined with the greenish-dark colouring and frequently the scaly structure of the Triassic formation distinguish them from the underlying coal-bearing part of the section, which they overlie without any apparent unconformity, so that the dividing line between the two is a purely conventional one, being taken to coincide with the rocks of the roof of the upper coal stratum. The upper part of the section is terminated by two strata of basalts followed by a break in the exposure, for which reason the upper boundary of the Triassic formations remains unascertained. In different horizons of this section, beginnig with the lower boundary of the Trias, there were found, in addition to the *Pelecypoda* and *Ostracoda* as to *Estheria minuta* (?) G o l d f., also insects determined by A. V. Martynov as *Ademosynoides asiatica* n. sp., orthopteran *(Prothorthoptera)* and multipeds. Among the vegetable remains the author determined (5): *Tomiostrobus radiatus* n. g. n. sp., *Araucarites tomiensis* n. sp., *Retinosporites (?) sibirica* n. sp., *Pecopteris augusta* Hr., *Cladophlebis pygmea* n. sp., *Baiera* sp. According to these data this part of Babiy Kamen section may be referred to the Upper Trias, since, with the exception of *Estheria minuta* (?) G o l d f. no insects from the family of *Ademosynoides* have hitherto been found outside the Upper Triassic deposits of Australia, while as regards the vegetable remains, the *Pecopteris augusta* Hr. is characteristic of the Upper Trias of Switzerland.

There are no elements of paleozoic flora in the Triassic part of section, and the last time they occur they are represented by a smal form of *Cordaites (Noeggerathiopsis) aequalis* G o e p p. sp., f. minima n. f. in the formation underlying the Trias, i. e. in the rocks of the roof of the upper coal stratum.

Further investigations possibly induce us to refer to the Lower Triassic age also a certain art of those coal-bearing strata underlying the Trias which are at present regarded as Permian, but no data that would justify such a procedure are so far available.

The disturbance of coal forming conditions, the extinction of the paleozoic flora and its substitution by the mesozoic type of flora may conceivably be put down to some orogenic movement which had gained in vigour by the commencement of the Upper Trias and, apparently, took place beyond the limits of Kuznetsk Basin, resulting in the change of the general physico-geographical conditions. As to the Kuznetsk basin proper, the movements which occurred in the Upper Triassic era were manifested by vulcanic activity, the result being that a considerable admixture of tuffogenous material is to be found in normal sediments. If the basalts comprised in the section of Babiy Kamen are to be regarded as a sill, as has been suggested by some

investigators in recent years (5), and not as a cover, as was thought formerly, then these basalts are of a more recent formation and are due to more recent manifestation of vulcanic activity on the territory in question. Towards the end of the Trias these orogenic movements resulted in a considerable plication (the Lower-Cimmerian), which embraced the Upper Paleozoic and the Triassic rocks. As a result of subsequent erosion the Triassic as well as part of Upper Paleozoic rocks had been washed off over a considerable area of their development before the deposition of the jurassic formations began, only some of them being preserved in the central, and possibly in the south-eastern part of the basin.

With the identification of the Trias, the section of coal-bearing formations in Kuznetsk Basin becomes indeed a classical one, and may be used as a basis in the study of the continental sediments of North Asia. At the same time the identification of the Trias makes it necessary to supplement the scheme of classification of coal-bearing formations in the Kuznetsk Basin formerly suggested by M. E. Neiburg (1929—1934). That part of Babiy Kamen section which is now referred to the Trias and which used to be regarded as Permian, due to absence of paleontological data and in view of continuous stratification (part of series II_2), is now marked in this scheme as series III_1, while the overlying series of Jurassic age is termd III_2, as according to the vegetable remains the new suite belongs to the mesozoic and to the paleozoic era, although it is connected with the latter by a more continuous stratification.

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MINERALOGY

ON THE DIAMOND FROM THE NEW DEPOSIT IN THE SYUREN RIVER BASIN (THE BASHKIR ASSR)

By V. A. ZILBERMINZ and E. M. BONSTEDT

(Communicated by V. I. Vernadskij, Member of the Academy, 20. IV. 1936)

I*

In the summer of 1935, in passing through Dmitrievski village, Zilair district (the Bashkir SSR) I happened to visit the local contributors' workings (situated as usual on the outskirts of long abandoned gold placers). Being interested in slicks and pebbles I made enquiries as to such finds, more especially, as to finds of transparent quartz pebbles. The contributor A. G. Velikžanin, my informant, gave me two crystals, one of which proved to be a small prism of rock crystal, and the other, a splendid diamond a little over one carat in weight. Having preserved this find, in full ignorance of its value, A. G. Velikžanin has thus contributed to the discovery in the Urals of a new diamond-bearing area.

I was informed that both crystals had been removed from the screen during the washing of auriferous sands near Shkaroda village on Great Syuren river, at the mouth of Bityan-Kunyak brook. When visiting the placer, I was shown by other contributors a number of crystals of rock crystal, which appear to be pretty common here. The pebbles are for the most derived from Devonian shales, the gold particles are exceedingly minute and are largely lost in the process of washing, which is done on rather primitive table. In the majority of cases, local people have not been engaged in gold washing for a long time and are therefore deficient in that mineralogical discrimination, so characteristic of the more experienced Ural contributors; they therefore pay but scant attention to pebbles.

The first discovery of diamonds in the Urals (1) is known to have been made in 1829 at Adolfovski mine, on the Poludenka river, at $1^1/_4$ km to the west of Krestovozdvizhenski mine; subsequently (up to 1908), over 200 diamonds were found at the mine; all of them were characterized by a great purity and transparency, the absence of a crust and, not infrequently, by a very clearly defined crystalline shape. As a rule, their weight was small (about $^1/_4$ carat),

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* By V. A. Zilberminz.

but crystals weighing over a carat were occasionally encountered, and, in two instances, weights of $2^{5}/_{16}$ and $2^{15}/_{32}$ caratas are on record (2).

The diamond from the new Syuren deposit weighs 0.2390 g, *i. e.* 1.165 carats, a fairly large size for the Urals. According to the pycnometric determination made by E. P. Pegušina, its specific gravity is 3.494; the low value of the specific gravity, which usually ranges from 3.51 to 3.52, is due, as in the case described by V. I. Mamontov (1), to the presence of minute black inclusions.

According to the list compiled by A. E. Fersman (2), the new deposit is the 19th (if the doubtful deposits No 15, Iltabanovski mine, and No 18, Krasnoufimski district, are left out of account).

The geology of the river Syuren basin has been but imperfectly studied. According to the geological itinerary map compiled by I. S. Librovič (3), the district in the placers of which the new diamond was found is made up of sandstones and shales of Zilair series ($D_3^2+C_1^1$).

In the absence of a more detailed study, it is difficult to form any conjecture as to the resemblance or otherwise of the newly discovered district to other diamond fields, and more especially to Goroblagodatski, Bisserski and Verkhissetski fields.

At any rate, the discovery of a new diamond-bearing area in the Urals brings to the fore the question of the advisability of more detailed investigations, both with a view to a comparative study of the geology of the district and also with the object of starting the necessary prospecting work.

II*

The crystal has an octahedral shape, with rounded faces, its triaxial dimensions being about 6—7 mm. The diamond is transparent, practically colourless, with but a slight yellowish tinge.

An examination through a magnifying glass shows that as a matter of fact the faces of the octahedron, or rather of the two tetrahedra, are quite undeveloped, having been superseded by the imperfectly formed convex sides of a hexakis tetrahedron; the edges between the sides are more prominently marked near the emergence of the triple axis, whereafter they become imperceptible, allowing the sides of the hexakis tetrahedra to merge and to form the rounded faces of a rhombic dodecahedron (Fig. 1).

When the crystal is measured with a Goldschmidt bicircular goniometer, the picture obtained is the one represented in the gnomonic projection in Fig. 2. There is not a single reflex that would correspond to a definite face, the reflexes obtained by reflexion from the convex surface being peculiar, broad, slightly curved light rays. These rays originate near the points corresponding to the sides of the octahedra (tetrahedra) and stretch without a break, but with a slight loss of intensity, across the points corresponding to the sides of the rhombic dodecahedron.

In their monograph on diamonds, A. E. Fersman and V. Goldschimdt (4), after having studied a great number of crystals, subdivide simple crystals into 6 groups: 1) crystals characterized by a predominance of the octahedron and due to growth; 2) crystals showing a transition from the octahedron to the dodecahedron; 3) ditto, but with incipient faces of a cube; 4) the octahedron as a result of growth, and the cube as a result of dissolution in equilibrium; 5) crystals with a predominance of the cube as a result of dissolution and

* By E. M. Bonstedt.

6) crystals with a typical hemihedrism (with phenomena of growth and dissolution).

Type 2) is the most widely distributed in nature; some crystals of this type show a predominance of the octahedron over the dodecahedron, this being characteristic of South-African diamonds; in other crystals, the faces of the octahedron are superseded by the rounded faces of the dodecahedron (crystals of Brazil and of South-West Africa). The crystal under consideration is of the last-named subtype; it is very much like many Brazilian crystals and is a nearly exact replica of the crystals reproduced by Rose-Sadebek and by Hauy. Similar Ural crystals are apparently also described by

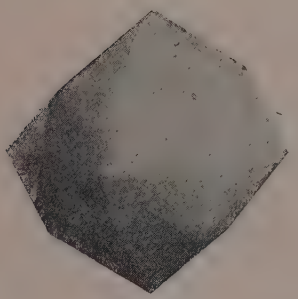

Fig. 1.

Fig. 2.

Eremeyev ([5]) as coming from Bisserski forest, from the Kochkar gold placers and from Sanarka River.

The crystal under consideration, if examined in the light of A. E. Fersman's and V. Goldschmidt's data, may give rise to the following considerations: In the last moments of its life the crystal had been dissolved, the picture of the light rays observed during measurement being typical of a crystal in the stage of dissolution. At present, we cannot discover on it any vestiges indicating the conditions of its growth or the shape resulting form its original growth; the octahedron faces which had beem formed during the growth of the crystal were gradually superseded by the rounded faces of the hexakis tetrahedron owing to the action of dissolving agents.

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GENETICS

A NEW DATA ABOUT THE CHROMOSOME NUMBER IN DOMESTIC SHEEP

By G. M. PCHAKADZE

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In spite of the fact that several investigations devoted themselves to study of caryotype of the domestic sheep, the principal question—chromosome number in this animal—cannot be considered as finally decided.

According to Živago's investigation (1) in the nucleus of the amnion cells of the sheep one can never see more than 54 chromosomes. However, the cases were found in which the number of separate chromosome components was considerably smaller varying from 48 to 53. So far as the 54 chromosomes were met with in the great majority of cases this number according to Živago's investigation has to be considered the diploid number of chromosomes in the sheep.

On the other hand, Wodsedalek found (2) that the diploid number of chromosomes in the sheep is 33 and 34 for the male and female respectively.

However, Krallinger (3) established still a different chromosome number in the aminal in question. Studying the spermatogenesis in the sheep this author came to the conclusion that the diploid number of chromosomes is 60. According to his observation the haploid chromosome sets at maturation division were clearly represented by 30 separate components.

While using the Georgian fat-tailed sheep for other lines of study the writer fixed testes material of this strain and studied the maturation divisions in spermatogenesis. The chromosome number observed in our material differed from the findings of Živago and Wodsedalek. Accordingly we fixed the testes of this strain again using some fixatives (such as Flemming's solution—with or without acetic acid—Shampy, Hance etc.). Most satisfactory results were obtained with Hance's fixative applied at 0° C. After fixation the material was washed in running water and embedded in paraffin in the usual way. Sections of 10 microns in thickness were stained with Heidenhain's iron haematoxylin. The drawings were made with the help of a camera lucida (10× and 20× oculars and $^1/_{12}$ immersion objective) the microscope tube being set at 170 mm.

The chromosome countings were made on the equatorial plates of the first maturation division. The spermatogonial plates were not suitable for our purpose in consequence of large number and crowded condition of the

chromosomes. For chromosome countings there were selected only the very good and clear plates which could not leave any doubt as to the number of separate components present.

Observing the equatorial plates represented in the figure, one can see that amongst a copmlex of chromosomes of varying size, and predominantly spheric in shape, there are two V-shaped chromosomes somewhat larger than the rest. A close examination, however, shows that one of these components consists of two independent chromosomes lying so closely to one another that one gets easily the impression of a single lagre chromosome. All the other chromosomes lie more or less separatly and can easily be counted.

The chromosome counts based on the comparatively lagre number of metaphase plates of the first maturation division undoubtedly show that the haploid chromosome number is 30, although in some cases only 28 chromosomes were observed. The presence of plates with 28 chromosomes, however, have

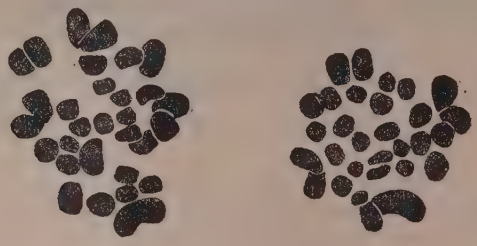

Fig. 1.

to be explained as a result of inexact counting of the chromosomes in less successful plates or as a result of the loss of some chromosomes at the cutting with the microtome. The large chromosomes usually lie towards the periphery of the plate while the small chromosomes occupy the center. This typical distribution is subject to some variation.

The present writer, therefore, concludes that the haploid chromosome number for Georgian fat-tailed sheep is 30 which is quite in agreement with the number found in the domestic sheeps by Krallinger and is different from that of Živago and Wodsedalek. This discrepancy in relation to the chromosome number of the sheep can not be, in our opinion, ascribed to some kind of mistake in Živago's or Wodsedalek's observations but it must be rather explained by the presence of the different races of sheep having the different number of chromosomes (60 or 54). The case in point was found, for example, in domestic pigs where there is a racial difference in chromosome number (40 and 38). This statement, however calls for further proof *.

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* While this article was in press a paper of N. Butarin ([4]) appeared in which he found the same number of chromosome (30) in arkhar, fat rumped ram, and their F_1 hybrids.

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GENETICS

SEX-LINKED HEREDITY IN *PTEROMALUS PUPARUM*

By R. L. DOZORCEVA

(Communicated by A. A. Sapehin, Member of the Ukrainian Academy 26. V. 1936)

Like *Habrobracon* and many other *Hymenoptera*, *Pteromalus puparum* normally gives haploid males from unfertilized eggs, and females from fertilized eggs. We made it our object to find out whether Whiting's hypothesis (P. W. Whiting, 1933) on sex determination in *Habrobracon* may also be applied to our object. An analysis of the behaviour of sex-linked factors in *P. puparum* might serve as a means of checking the correctness of this hypothesis.

We succeded in finding such a factor soon after we had started our work. In our experiments in artificial mutations, we obtained 18 red-eyed males, two of which proved to be fertile. These males were crossed to normal dark-eyed females. The resulting heterozygous females with normal eyes were crossed again to red-eyed males and also multiplied parthenogenetically. In the latter case the heterozygous females always produced both normal and red-eyed males, in approximately equal numbers (1 : 1), as migth be expected. As a result of crossing, we obtained either only normal individuals, or both normal males and an insignificant number of red-eyed females, or vice versa. These data suggested us the idea that the character in question is sex-linked and that there exist in *P. puparum* two types of males with X and Y chromosomes, the females being heterogametic (XY), as conjectured by Whiting with regard to *Habrobracon*. If red eyes were not a sex-linked character, then, in the case of a back-crossing, we had to expect an equal number of red-eyed and normal individuals among both sexes. We should also expect an equal number of normal and red-eyed females when applying the usual procedure of sex determination of *P. puparum* (a female—XX, a male—X) in investigating sex-linked characters. It should be admitted that the mutant females have a sharply reduced viability as compared with the wild type and with mutant males. However, in our cases such a conclusion must be ruled out due to following considerations. On the one hand, the progeny of heterozygous females consists of an approximately equal number of mutant and normal males. 69 heterozygous virgin females bore 2875 red-eyed and 3224 normal males. On the other hand, in crossing red-eyed females to red-eyed males, the ratio of females from fertilized eggs to males from unfertilized eggs is nearly equal to that of the control; thus, it would seem that the viability

of the red-eyed females is not lower than that of the red-eyed males. In normal culture we obtained 2878 females as against 3090 males. The crossing of red-eyed females to red-eyed males resulted in 102 females as against 187 males; although, in this case, the number of females is relatively somewhat lower, the total absence of red-eyed females in the progeny of back crossings is obviously not due to their death. It should be noted that, notwithstanding their high viability, red-eyed females often prove to be sterile, so that it is rather difficult to obtain any offspring from them.

Table 1

No	Parents		Offsrping				Hypothetical type of crossing
			Females		Males		
	Females	Males	Red-eyed	Normal	Red-eyed	Normal	
1	Normal heterozygous females	Red-eyed males	3	67	10	5	$AX\,aY \times aY$ or $AY\,aX \times aX$
2	»	»	6	28	12	65	»
3	»	»	—	40	50	75	»
4	»	»	3	9	128	138	»
5	»	»	—	26	31	39	»
6	»	»	—	36	26	31	»
7	»	»	4	41	31	25	»
8	»	»	6	23	33	35	»
9	»	»	33	13	13	11	$AY\,aX \times aY$ or $AX\,aY \times aX$
10	»	»	43	39	3	9	»
	Total . . .		98	320	357	433	

Table 1 shows the results obtained in back crossings of females heterozygous in regard to red eyes to their red-eyed fathers. In the first eight cases of Table 1 (1—8), we find a sharp preponderance of the females of the wild type. In one case (9) we find a noticeable excess of red-eyed females. And, finally, in one case (10) an almost equal number of red-eyed and normal females, is to be observed.

Assuming that, according to Whiting's theory for *Harbrobracon*, there are two types of males *in P. puparum*, and that red-eyes are a sex-linked character, four types of crossings of females heterozygous in respect of red eyes to red-eyed males are theoretically probable. Table 2 shows the results expected in each of the four possible crossings. In cases 1 and 2 only normal females should appear, in cases 3 and 4, only red-eyed males. The ratio of normal males to red-eyed ones should be (1 : 1) in all cases, as the males develop from unfertilized eggs.

Following Whiting's scheme (1935), we shall designate the red eyes factor investigated by us by a and its dominant allelomorph by A, then the recessive male must be either aX or aY, while the heterozygous female should be AX (aX or AY) aX; it would seem that, in cases 1—8 of Table 1, $AXaY$ females were crossed to aY males, or $AXaX$ females to aY males, while in case 9, aY/aX females were crossed to aY males, or AX/aY females to aX males (Table 2).

Table 2

Results expected in four possible crossings of a heterozygous female to a red-eyed male, assuming that there exist two types of males (*X* and *Y*) and that redeyes are a completely sex-linked character

Crossings	Parents		F_1 Offspring		Phenotype of F_1 females
	Males	Females	Males	Females	
1	*aY*	*AX/aY*	*ay AX*	*AX/aY*	Normal
2	*aX*	*AY/aX*	*AY aX*	*AY/aX*	»
3	*aY*	*AY/aX*	*AY aX*	*aX/aY*	Red-eyed
4	*aX*	*AY/aY*	*AY aY*	*aY/aX*	»

The first nine cases lead us to the conclusion that the red-eye factor is strongly linked to the sex-determining factors, but, as in the case described by Whiting it is not completely sex-linked, since crossing over between the red-eye gene and the sex-determining factors still occurs and is equal to 7.63 per cent for cases 1—8 and to 28.27 per cent for case 9. In this case, the percentage of crossing over is expected to be nearly equal in both cases. The difference obtained by us may be due to the very small number of observations in case 9.

As regards case 10, it is as yet difficult to account for it on the basis of our data. Following Whiting, who observed similar cases in *Habrobracon*, we are inclined to believe that a break of the sex-chromosome and the translocation of the red-eye factor to one of the autosomes has occured, although it is our opinion that this case requires careful checking and further investigation.

I acknowledge my deep gratitude to J. J. Lus and S. M. Gershenson for their help and criticism of this paper.

Conclusions

1. The red-eye gene in *P. puparum* has been investigated by means of crossing heterozygous females to recessive red-eyed males (fathers of these females), as well as in the case of parthenogenetic reproduction of virgin heterozygous females.

2. The results obtained have shown that, among the males, the ratio of normal individuals to red-eyed ones is 1 : 1, while there is a considerable departure from this ratio in the case of females. In the offspring of heterozygous females back crossed to red-eyed males in eight cases there was a considerable excess of normal females over the red-eyed ones, in one case a predominance of mutant red-eyed females was obtained and in one case the quantity of normal and red-eyed females was nearly equal.

3. With regard to the first nine cases, it is assumed that the red-eye factor under investigation is strongly linked to the region of the sex chromosome carrying the sex-determining factors, but, due to crossing over, which is equal to 7.53 per cent for cases 1—8 and to 28.27 per cent for case 9, this factor is not completely sex-linked. The discrepancy between the figures obtained in these two cases seems to be due to a very small number of individuals used in case 9. It is believed that a break and the translocation of red-eye

factor to one of the autosomes occured in case 10, although we are of the opinion that this case requires careful checking and further investigation.

4. All the data set forth above show that the red-eye character in *P. puparum* is sex-linked.

5. The experiments yielded certain data pointing to the poor fertility and viability of the mutant red-eyed type.

6. Thus, genetic data confirm the cytological data previously obtained by us and show that the mechanism of sex determination in *P. puparum* is similar to that described for *Habrobracon*.

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GENETICS

THE MORPHOLOGY OF CHROMOSOMES IN THE ICHNEUMON *PTEROMALUS PUPARUM*

By R. L. DOZORCEVA

(Communicated by A. A. Sapehin, Member of the Ukrainian Academy, 26. V. 1936)

The study of the cytology of *Hymenoptera* was started when many biological and experimental investigations of parthenogenesis had been made. Cytological work with *Hymenoptera* began as far back as 1901. It was established already in the first works, which were far from being accurate, that the course of oogenesis in *Hymenoptera* is quite normal, while unusual phenomena are to be observed in the spermatogenesis. Petrunkevich, Nachtsheim, Meves, Doncaster, Sanderson and other authors investigated the cytology of *Hymenoptera* for a long while. The majority of authors came to the conclusion that the first meiotic division in the spermatogenesis of *Hymenoptera* is abortive and leads to the separation of plasmatic gemma, while the second division is equational, as is characteristic for haploid individuals.

As regards the computation of chromosome numbers and the study of their morphology, we hardly have a single work on this group of insects containing accurately computed chromosome numbers and detailed descriptions of the chromosomes morphology. The fact that the majority of the authors, who studied the cytology of parasitic *Hymenoptera* directed their attention chiefly to spermatogenesis, seems to be due, on the one hand, to the ease with which the material for the analyis of gonads may be obtained and, on the other hand, to the interest attaching to the abortiveness of the first division, which distinguishes the spermatogenesis of *Hymenoptera* from that of other animals. In the last paper on this problem, published in 1933. Sanderson pointed out that the chromosomes number had been established for 30 species of *Hymenoptera*.

In 1935 Groeb published a paper on cytology and spermatogenesis of *Habrobracon*. The author investigated normal haploid males, diploid males and diploid females.

The work contains reliable data on the number and general structure of chromosomes and the course of spermatogenesis in this ichneumon. The author established 10 chromosomes for normal haploid males, 20 chromosomes for normal diploid females and 20 for normal diploid males.

Material and Method

Simultaneously with genetic investigations we conducted a cytological analysis of our subject. It was the aim of this part of our investigation to establish the number and morphology of the chromosomes, as well as to find out the chromosome relations in males and females as compared with other *Hymenoptera*. Hitherto nobody has studied the chromosome complex of this ichneumon and no information on this subject is available. As material for this investigation we used imaginal discs, nerve ganglia and intestinal cells of 6, 7 and 8 days old larvae. Whole larvae were placed in the fixative, where they were pricked with a needle, or cut into pieces, and thus underwent further treatment.

After fixation the material was treated with alcohols, xylene and poured over with paraffin. The staining was accomplished by Heidenhain's iron haematoxylin.

Several fixatives were tested, the best results being obtained by fixing larvae with a strong mixture of chromic formalin (50% formalin+5% chromic acid) of a composition 5 : 5. Analogous results for the same fixative have been obtained by Levitsky (1931) with the chromosomes of certain plants and by Prokofjeva (1933) and Butarin (1934) with the chromosomes of certain animals.

Morhpology of Chromosomes

In a preliminary paper written jointly with Guhl (Guhl and Dozorceva, 1934), we have shown that the ichneumon males have a haploid set of five chromosomes. The females are diploid and contain 10 chromosomes. Our present investigation corroborates these fully data on the chromosome number.

An examination of chromosome plates, both in the diploid and haploid set, leads to the conclusion that nearly all the chromosomes are double-armed with constrictions of different types. On some plates, in the haploid set, all the chromosomes have two arms, one kinetic constriction and a median attachment of the spindle fibre; on others, there are four V-shaped chromosomes and a club-shaped one. On some plates, the latter has a proximal head, while on others it has instead of a head a short arm seperated from the other arm of the chromosome by a kinetic constriction which is not always very clearly marked. The latter chromosome is best seen in the diploid set. In the diploid set, we observed 4 pairs of V-shaped chromosomes with a median attachment of the spindle fibre and one heteromorphous pair. One component of the latter pair is a small V-shaped chromosome, while the other is a club-shaped chromosome with unequal arms.

We did not succeed in discovering any sharp difference in the morphological structure of the chromosomes in females and males. The chromosomes were identified by their size and general shape.

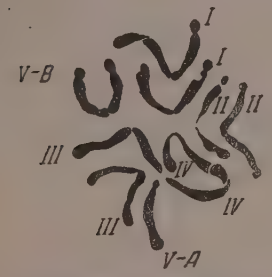
The Chromosomes of the Male

Chromosome I. The largest with almost equal arms and a median position of the kinetic constriction.

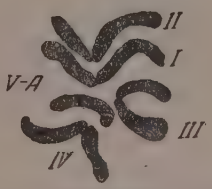
Chromosome II. Double-armed, has equal arms on the majority of plates and the primary constriction in the form of an isthmus. Each arm has, in its turn, secondary constrictions.

Chromosomes III and IV. We have not yet succeeded in distinguishing them from one another. They are also double-armed, the arms being nearly equal. One of them (let us call it III) has a satellite attached by a fibre to the distal head of the chromosome. The double structure of the satellite due to metaphatic splitting may be seen on some of the plates. The other of these chromosomes (let us call it IV) has a proximal head on one arm; sometimes a longitudinal metaphatic splitting is observed to occur in this arm.

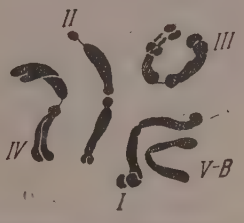
Chromosome *Y*. In some cases, it is a small V-shaped chromosome with equal arms. On some of the plates, a small head is to be observed on one arm; in other cases, this chromosome is club-shaped or has markedly unequal arms.



Chromosomes in the diploid set of the female. (Strongly concentrated chromic formalin «5 : 5»).



Chromosomes the in haploid set of the male. (Navashin 1041).



(Strongly concen trated chromic formalin «5 : 5»).

The Chromosomes of the Female

The diploid group consists of 4 pairs of double-armed chromosomes and one heteromorphous pair, in which two types of chromosomes occuring in the haploid set of male are represented, viz. *A* and *B* chromosomes.

The morphology of the chromosomes in the diploid set of the female is the same as that in the haploid set of the male. It is possible that the heteromorphous pair consists of *X* chromosomes.

Thus, we succeeded in establishing that the chromosomes of *P. puparum*, similarly to those of other animals and plants, have two arms, with the exception of the pair, which seems to consist of *X* chromosomes.

On some of the plates, a secondary division was discovered but it was not equally clear on all the plates, which seems to be due to difference in the degree of differentiation.

I wish express my deepest gratitude to A. A. Prokofjeva for a number of valuable suggestions and her criticism of this paper.

Conclusions

1. It has been established that the haploid set of the male consists of four double-armed chromosomes, which, in all probability, are autosomes, and of one *X* chromosome, which is V-shaped on some plates, while on others it is either club-shaped or has unequal arms, the lenght of the short arm being varied.

2. The diploid set of the female consists of four pairs of double-armed chromosomes (which are also autosomes, in all probability) and of one heteromorphous pair of *X* chromosomes.

3. All the chromosomes investigated had a primary division with a median attachement of the spindle fibre, with the exception of one of the *X* chromosomes, which had a subterminal kinetic constriction.

4. An individuality was established for the I, II and V pairs of chromosomes, whereas we failed to establish an individuality for the III and IV pairs.

5. Larvae aged from 6 to 8 days were found to be the best stage for studying the morphological structure of the chromosomes in *P. puparum*.

6. Strongly concentrated chromic formalin (50% formalin +5% chromic acid) of a 5 : 5 composition was found to be the best fixative for bringing out the morphology of the chromosomes.

7. It has been found that all the chromosomes of *P. puparum*, both of the haploid and diploid set have a clearly marked morphological structure characterized by the presence of primary and secondary constrictions in the form of isthmuses, compressions and achromatic breaks. Some of the chromosomes have heads and satellites.

8. In all probability, the *X* chromosomes are heteromorphous, and their distinctions are better shown on the diploid plates.

9. The haploid set of males does not differ from the diploid set of females in the morphological structure of chromosomes.

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PLANT PHYSIOLOGY

ON THE CAUSES OF PRE- and POST-FLORAL MOVEMENTS OF PEDUNCLES AND SCAPES (of the genera *Papaver*, *Crepis* and *Tussilago*)

By V. M. KATUNSKIJ

(Communicated by A. A. Richter, Member of the Academy, 15. V. 1936)

The phenomenon of floral movements is of very wide occurrence in the plant world. Almost in all families of the *Angiospermae* we have representatives possessing floral movements of some sort. All the forms of floral movements have one feature in common, viz., they do not accord with the negative geotropic response, which usually forms the basis of the spatial orientation of peduncles and scapes.

The most common floral movement is the so-called drooping, when the peduncle temporarily hangs vertically down, usually in its upper part only. The complete cycle of floral movements in the genera *Papaver* and *Crepis*, studied by us, consists in the young flower stalk first being upright, then drooping and later again straightening out, not long before flowering.

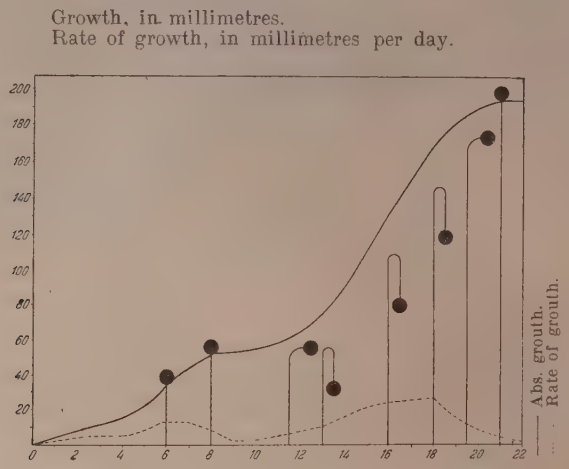
Although the problem of the physiological nature of floral movements is an old one and has many investigations devoted to it, it has not yet found a more or less satisfactory solution. Investigations into this problem proceed along two main lines of inquiry. The fisrt line dates from 1882. It originated in the classical works of Vöchting (1). It was further developed by Fünfstück (2) and Scholtz (3). In modern times, it is pursued by Schulz (4) and Fitting (5). This line considers drooping to be a consequence of the positive geotropic response, which usually appears in the negatively geotropic peduncle only during the drooping stage.

The second line of inquiry is of relatively recent origin and is due to studies of the phenomena of plagiotropism and epinasty in plants by Lundegardh, Zimmermann, Rawitscher (6) and others. Floral movements are regarded by these authors as epinasty caused by the physiological dorsiventrality of the peduncle, induced by gravity. They deny the presence of positive geotropism in the phenomenon of the drooping of peduncles. Vöchting emitted in his time the suggestion that the drooping of flower stalks was associated with the activity of their flower buds, which he considered to be the organs responding to geotropic stimulus.

Vöchting's main proof of the part played by flower buds was his experiment with the decapitation of peduncles. After decapitation, they straighten-

ed out prematurely, even when they were weighted with a load exceeding 3—5 times the weight of the removed bud.

But later, beginning with the investigations of Schulz and Fitting, this notion of Vöchting's was always rejected (e. g. Rawitscher, Zollikofer, and others). The present work was undertaken with a view to a critical and experimental re-investigation of the problem, in particular from the standpoint of the Kholodny-Went hormone theory, which is at the present moment the best founded theory of growth movements. The wide-spread modern notion considering the floral movements as associated with growth was, therefore, the first to be critically examined. For this purpose, the dynamics of the grouwth of peduncles and scapes and the succession of the stages of floral movements were studied on *Papaver nudicaule*, *P. Rhoeas*, *Crepis rubra* and *C. fetida*. We distinguished three such stages: primary erect position, drooping, and secondary erect position (i. e. after straightening out). As



a result of our work we have found a correlation common to all the subjects investigated. This correlation is graphically represented on the figure.

In examining the S-shaped growth curve obtained twice in our experiments and the corresponding stages of floral movement one notices the following correlations: (a) the stage of drooping corresponds (in time) with the period of the most vigorous growth, while the moment of its beginning coincides with the beginning of the second cycle of growth;(b) the stage of straightening out corresponds with upper inflection of the growth curve, i. e. lies on the boundary of the full cessation of growth of the organ (in *Papaver* and *Crepis*). In *Papaver* and *Crepis* we had to deal with cases of prefloral movement, but we also studied *Tussilago Farfara* which manifests a post-floral drooping of scape. A completely analogous correlation was established in regard to *Tussilago*, with the only difference that in it the period of the greatest growth and drooping occurs after flowering (more exactly after fertilization, as has been established by Zollikofer). A series of experiments was then made to determine the role of flower buds in floral movements. The peduncles of *Papaver nudicaule* were decapitated for this purpose in the drooping stage,

and gelatin (or agar) blocks with the diffused extract (after Went) from the ovules taken out of the buds of peduncle at the same stage of floral movement, were implanted on the cuts of the flower bud.

Such peduncles, contrary to what is usually observed after decapitation, showed no premature straightening out. In these experiments, best results were obtained when the ovules had been first placed in liquid gelatin, and the blocks for the cut surfaces of the decapitated peduncles were then prepared out of this gelatin. These experiments refute usual objections against Vöchting's hypothesis of the role of flower buds based on the assumption that the straightening out after decapitation is caused, not by the decapitation as such, but by the traumatization associated with it. In our experiments, trauma also existed, of course, but no straightening out was to be observed.

All the known cases of traumatization causing premature straightening out are associated with injuries of the flower bud (e. g. shading resulting in disturbed embryogenesis, dressing with gypsum, etc.), or with a disarangement of the transport of the substances produced by the bud.

The extract of ovules obtained in the above experiments was examined for growth hormone after Went's method. This work showed that the content of growth-promoting substance in the ovules, taken from flower buds in the drooping stage, exceeds 40—60 (and more) times its content in the preceding and following stages of floral movement. Lastly, a series of experiments was carried out to determine whether drooping may be considered an active growth movement in the usual sence of that term, i. e. a movement resulting from physiological dorsiventrality, uneven growth, etc. For this purpose the floral buds were held up by a thread passing over a light pulley and having a load attached to its end. Peduncles having buds fixed in that manner drooped only when the load was much lighter than the growing weight of the flower bud. In all other cases there was no drooping. These data fully accord with those found in the literature, in which there is no evidence whatever of the positive geotropism of drooping peduncles. The idea of such a geotropism is due only to conclusions based on analogy. Therefore, we have to consider the drooping of peduncles to be a passive movement arising under the action of gravity and due to their great plasticity. All who have had to deal with the phenomenon of drooping know well both the remarkable plasticity of peduncles during the drooping stage and the loss of such plasticity during natural or premature (caused by decapitation) straightening out. As a result of all that has been stated above we are faced with the following contradiction: on the one hand, there is an obvious relation between the floral movement and the growth curve, and, on the other hand, drooping itself is found to be a passive movement. This contradiction can be removed with the aid of our modern conception of the mechanism of growth and the action of the growth-promoting hormone (auxine) on cells. The fact is that the studies of Horreus de Haas (7) and Söding (8), and, especially, those of Heyn (9) have established that the growth-promoting hormone markedly increases the plasticity of cell walls. These last studies and our data permit us to make the following general conclusions:

1. The floral movements of drooping are not those of growth but are completely and exclusively due to the plasticity of the peduncle during the drooping stage, which is, in its turn due to the over-production of growth-promoting hormone by the flower buds during this stage of floral movement.

2. The centre of formation of growth-promoting hormone in flower buds are the growing ovules (the removal of the androecium does not cause premature straightening out).

3. Both the normal straightening out of peduncles after the drooping stage and their premature straightening out following decapitation are caused by the decrease of growth-promoting hormone supplied by the flower buds; this entails a decrease in the plasticity of peduncles resulting in a normal negative geotropic response which causes the peduncles to straighten out.

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PLANT PHYSIOLOGY

THE DEVELOPMENT OF THE FEMALE GAMETOPHYTE AND THE PRODUCTION OF THE GROWTH-PROMOTING HORMONE BY FLOWER BUDS

By V. M. KATUNSKIJ

(Communicated by A. A. Richter, Member of the Academy, 15. V. 1936)

In the preceding note (*v. p.* 343) we have succeded in proving that the growth and floral movements of peduncles (and scapes) are directly dependent on the growth-promoting hormone secreted by the flower buds. We have also established in the same work that in the flower bud the centre of production of the growthpromoting hormone is the female gametophyte, or, more exactly, the developing ovules.

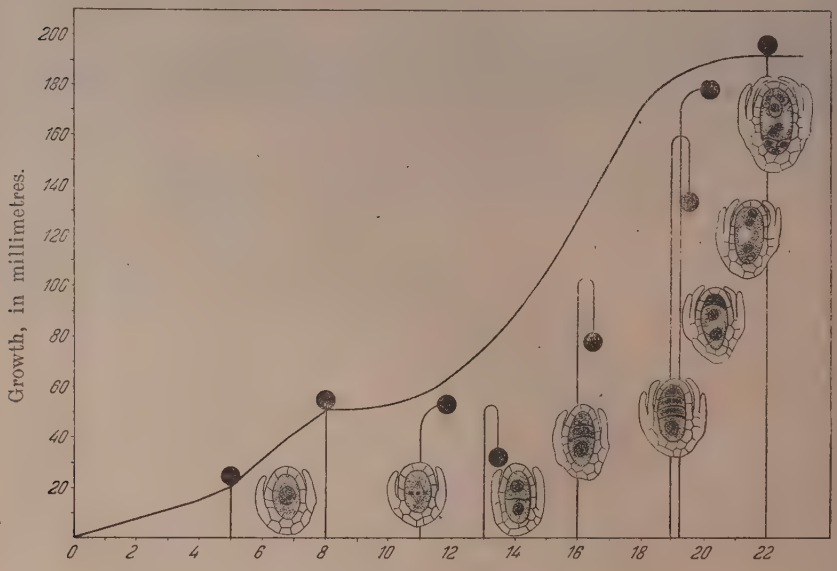
One can find in the literature many mentions of such a relation between the growth of the peduncles and the state of the flower-buds. So Miyake (1), for instance, has shown that the growth of the scape of the dandelion has two optima separated by a period of almost complete cessation of growth, which occurs during the flowering stage. It is interesting to note that Errera (2), in his study of the growth of *Sporangiophores*, also established that the growth of the fungus *Phycomyces* proceeds during two long periods with an intervening cessation of growth, occurring during the formation of the sporangia.

All the above stated naturally suggested that the stages of growth of the peduncles correspond with definite stages of development of the female gametophyte. This assumption was made the basis of this work, which was carried out with *Papaver nudicaule* and *P. Rhoeas*, as (according to our observation) these poppies are distinguished by an exceptionally clearly marked synchronism in the development of all the ovules in one ovary. Besides, the existence of a characteristic double S-shaped growth curve and a distinct correlation between it and the stages of floral movement had been established in our poppies, which we had already studied.

The work consisted in performing a lagre number of anatomo-cytological investigations of ovaries cut from peduncles at different stages of growth and floral movement. We distinguished the following three stages of growth and floral movement; (a) primary upright position and the first rise in growth rate, (b) drooping and the second rise in growth rate, (c) straightening out and cessation of growth. The material for the anatomo-cytological examinations was fixed and treated after the usual methods of microscopic technique.

The results obtained in our investigations of *Papaver nudicaule* and *P. Rhoeas* showed a complete agreement. They are represented graphically in the figure, where it will be seen that definite stages of floral movement and growth (a), (b) and (c) correspond with definite stages of macrosporogenesis.

The ovaries of peduncles which had prematurely straightened out under the influence of shading (after Fitting), were also examined. Under the microscope these ovaries revealed a retardation in the development of the female gametophyte and a number of abnormalities in the development of the other parts of the flower bud (e. g., a hypertrophic increase in size of the future embryo-sac).



A comparison of the stages of growth and floral movement with the corresponding stages of microsporogenesis has shown, with respect to both poppies investigated, the following characteristic (*v.* fig.):

1) The first rise in the growth curve (before drooping) coincides with the first appearance of the nucelli and their development until the differentiation of the mother-cells of the embryo-sacs. During this period cell divisions are mainly associated with the development of the nucellus and the integuments.

2) The first interruption in growth (completion of its first cycle) coincides with an almost complete cessation of cell division. The development of the female gametophyte (mother-cells of the embryo-sac) of this period consists of very long processes serving as a preparation for the reduction division, of which the first is synapsis (conjugation of homologous chromosomes with the formation of bivalents).

3) The beginning of the second rise in the growth curve (associated with the beginning of drooping) and its continuation up to a new fall coincides with

the period of maximum intensity of cell division in the development of the female gametophyte, as during this period are observed to occur two divisions of the mother-cells of the embryo-sacs (the first of which is a reduction division proper) as well as a vigorous development of the envelopes of the future ovule.

4) The second interruption in growth and its complete cessation (associated with the straightening out of the peduncles) coincides, in the development of the female gametophyte, with the stage of the reduction of the three macrospores and the subsequent development of the embryo-sac. The development of the embryo-sacs from the mother-cells (macrospores) is not accompanied with cell division proper, since the nuclei alone divide (three consecutive division of the nucleus of the mother-cell of the embryo-sac). On the basis of what has just been stated, we can make the following general conclusion: (a) the optima of growth and the corresponding maximum production of growth-promoting hormone by the flower buds are associated with such stages of development of the female gametophyte at which cell division proceeds with maximum intensity. (b) Periods of low growth rate or of complete arrest of growth and of corresponding minimum production of growth-promoting hormone are associated with periods of depression or complete cessation of cell division in the process of the development of the female gametophyte.

It is interesting that, according to the data of Zollikofer ([3]) and Proskoriakov ([4]) on *Tussilago Farfara*, and of Smitt ([5]) on *Digitalis purpurea*, *D. ambigua* and *Althea rosea*, the minimum, growth of the peduncles (scapes) of these plants, after its first optimum, coincides with the completion in the formation of the embryo-sacs, and that the second (greater) optimum of growth occurs after fertilization, i. e. when cell division has renewed in the ovary. It is also worthy of note that the second cycle of growth in these plants ceases by the time of the formation of the seeds, i. e. the cessation of embryonic processes associated with cell divisions. Therefore, on the basis of all that has been stated above, we are justified in drawing the following conclusion:

The production of growth-promoting hormons by flower buds (by their ovaries) and the growth of peduncles (scapes) depend on the development of the female gametophyte, the maximum production of growth-promoting hormone and the maximum growth occurring during those stages of development of the female gametophyte that are associated with vigorous cell division.

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PLANT PHYSIOLOGY

WINTER-HARDINESS AND EARLINESS OF WHEATS

By G. G. KOLOMYCEV

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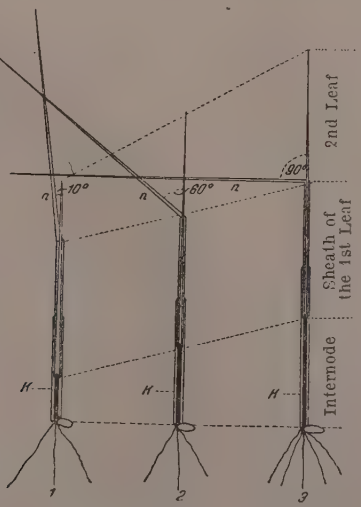
I. WINTER-HARDINESS

In the fig. is given a schematic representation of soft wheat sprouts: 1) Winter hardy *Lutescens* 01060—10; 2) non-hardy Zemka and 3) quick-ripening Garnet—all grown under identical conditions of low temperature (12° C) in diffused daylight*.

They are plainly shown:

1. The inconsiderable size of the 1st internode of the winter-hardy va-



* Coleoptile, blade (*n*) and sheath of the 1st leaf, 1st internode when mature, 2nd leaf in the stage of growth.

riety; the internode is greater in the case of the non-hardy form and greatest of all in the early spring variety.

2. The parallel changes in the length of the blade of the first true leaf; it is smallest in the winter-hardy variety and largest in the early spring wheat.

When the varieties are grown in the dark and at higher temperatures (22 to 27° C), the differences are somewhat smoothed: the internodes and leaves of the winter varieties become larger and approach in size the corresponding elements of the spring wheat.

The reduction of these elements in winter wheats when they are grown in the cold has been verified for the basic standard varieties. Winter-hardy ones: *Lutescens* 0329, *Lutescens* 01060—10, *Lutescens* 0675, *Ferrugineum* 01239, *Erythrospermum* 0917, *Hostianum* 237, *Erythrospermum* 01114, Minhardy; of medium hardiness: Durable, Moskovskaya 024—11, Ukrainka; non-hardy ones Novo-krymka 0102, Zarya, Zemka, *Apulikum* 77/2, *Nigroaristatum* 0622.

The more winter-hardy the variety, the shorter, on the average, is the 1st internode and the blade of the 1st leaf.

I give the data from one of the experiments carried out in the transplanting box (at 10 to 12° C) under weak diffused daylight, from February 25 to March 21, 1936; soil—hotbed humus with sand; depth of planting—3 cm.

The average figures from measurements of 25 seedlings of each variety are shown in Table 1. In Table 2 are shown the variations within the varieties.

Even within the limits of «pure-line» varieties, a selection of plants with a higher expression of the characters of winter-hardiness is possible*; infinitely greater possibilities in this direction are offered by «local strains», populations. It is the business of the plant breeder to select such plants and multiply them.

It has been shown by special experiments that the characters noted (length of the 1st internode and of the 1st leaf blade) do not, essentially, depend on size of seed; the latter determines primarily the length of the coleoptile, rate of the 2nd leaf's growth and the thickness of the internode.

On the other hand, it has been established that the reduction of these elements occurs under the following conditions: low temperature, increased illumination, insufficient moisture, excess of water-soluble salts in the soil, both taken separately and in their combined mutually-reinforcing action (the so-called «hardening»)**.

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* *Hostianum* 237, of the Saratov Station (1923), is noteworthy for its unusually great variation in lenght of the 1st internode—from 2.2 to 4.0 cm in different plants. According to data from the Saratov Station, this variety is inclined to «natural hybridization»; from it has been divided off the new variety 037/9, possessing a winter-hardiness that exceeds the former average. In it, too, is to be noted the «exceptionally valuable capacity of quickly recovering in the spring after severe winter conditions», a fact standing in undoubted relation with its deeplying «tillering node» and general winter-hardiness. According to all indications, *Hostianum* 237 is promising material for breeding new winter-hardy and economically valuable «lines».

** An analysis of the influence of various factors on the leaves, internodes, and whole plants of winter and spring crops will be given in a subsequent article, «On the Question of the Laws of Growth and Development of Plants». The influence of conditions of ripening, keeping and treating of seed material on the size of the first elements of the seedling is being studied. It is now plain that the influence of the external factors enumerated on the sprouting plant may be replaced, in so far as concerns the 1st leaf and the first internode, by the action during a short period of the same factors on the seeds when just beginning to germinate.

Table 1

Nos	Variety of wheat	Weight of 100 seeds in g	Length of 1st internode in cm	Length of blade of the 1st true leaf in cm
	A. Winter wheats			
	I. Hardy			
1	*Hostianum* 237	3.37	1.60	8.20
2	*Lutescens* 01060—10	2.74	2.76	9.06
3	*Ferrugineum* 01239	3.73	2.88	8.45
4	*Erythrospermum* 0917	3.23	3.06	8.43
	II. Moderately hardy			
5	Moscovskaya 24—11	3.67	3.78	11.40
6	Ukrainka	3.25	3.86	11.02
	III. Non-hardy			
7	Zemka	3.85	4.28	11.63
	B. Spring wheats			
8	Garnet	2.84	5.52	13.50

Table 2

Nos	*Lutescens* 01060—10		Ukrainka		Zemka	
	1 st internode in cm	Blade of 1st true leaf in cm	1 st internode in cm	Blade of 1st true leaf in cm	1st internode in cm	Blade of 1st true leaf in cm
1	2.3	9.3	3.7	11.7	4.4	11.7
2	2.6	8.8	4.3	11.1	4.3	12.1
3	3.2	9.0	3.7	11.4	4.2	11.1
4	**1.9**	8.7	4.0	11.4	4.2	10.7
5	2.7	8.1	3.9	9.5	4.4	11.5
6	2.6	9.3	4.1	11.0	4.3	10.4
7	2.9	9.9	3.5	11.9	4.4	10.1
8	3.0	8.5	**4.6**	11.4	4.6	12.8
9	3.0	9.4	4.0	11.8	4.3	11.2
10	3.0	9.7	4.0	11.2	4.4	12.5
11	2.6	9.2	4.0	11.7	4.2	12.4
12	3.2	10.0	3.6	10.4	3.9	12.1
13	2.9	8.7	4.0	11.1	**4.7**	10.4
14	2.6	9.5	3.5	12.0	3.9	11.8
15	**3.3**	9.5	3.7	12.6	4.3	10.6
16	2.4	8.4	3.8	10.6	4.2	12.4
17	2.7	9.2	3.7	10.5	4.6	12.5
18	2.7	8.8	4.4	10.1	4.3	12.5
19	2.8	9.8	3.4	11.6	4.4	12.8
20	2.5	8.4	4.1	10.4	4.2	12.7
21	2.3	9.4	**3.3**	10.3	4.5	11.8
22	2.8	8.8	3.7	9.8	4.1	12.2
23	3.3	8.5	3.7	11.0	4.6	10.5
24	2.4	8.6	4.0	11.4	4.0	10.3
25	3.2	8.7	3.9	9.6	**3.5**	11.7
Average	2.76	9.06	3.86	11.02	4.28	11.63

The growth of winter wheat sowed in summer, under field conditions, and producing leaf blades of up to 40 cm long before the onset of cold weather but shortening them to 10 or 12 cm in their late fall or early spring growth, is significant.

The specificity of the action of low temperatures on winter crops is especially marked when the action of other conditions restraining growth is excluded. Experiments were carried out in complete darkness, at temperatures of 10 to 12° C, and at optimal moisture of the soil (table 3).

Table 3

Variety of wheat	Length of 1st internode in cm	Length of blade of 1st leaf in cm
A. Hardy		
1. *Lutescens* 01060—10	6.47	12.19
2. *Ferrugineum* 01239	7.62	13.91
B. Non-hardy		
1. Novo-Krymka 0204	11.37	13.94
2. Zemka	13.65	13.97

In experiments to determine winter-hardiness, whether in the dark or in weak diffused daylight, seeds of definitely winter-hardy varieties should be sown, as a standard, in one box with those under test. The seeds taken should be fresh, not damp and approximately of the same weight as those under test. The same depth of planting (3—5 cm) and a homogeneous compactness of soil is necessary. The seeds should be placed at intervals of 2.0—2.5 cm, with the embryos upwards. No material decrease of the moisture of the soil may be permitted and, in experiments in the dark, no action of light on the seedlings. The plants should be taken out carefully after 25 to 30 days, when the blade of the second leaf has emerged from the sheath of the first leaf and has a length equal to about $^1/_3$ the length of the first true leaf. The growth of the first leaf and of the first internode is at this time quite completed. After measuring and sorting, the healthy, normally developed green or etiolated seedlings may be sown in other, deeper boxes with soil up to the blade of the first leaf and held till spring in daylight and at a lowered temperature to insure «vernalization».

Simplification of the method, rendering it more exact, especially as regards sprouting, sorting and keeping the material till spring (under field conditions, after Saltykovski's method, etc.) is a matter for further work.

Curtailing of growth of winter crops is bound up with a number of phenomena hitherto noted in the literature on winter-hardiness: accumulation of sugars, of nitrogen compounds, chlorophyll and dry substance, lowered respiration, decreased size of cells, high osmotic pressure, and the like. The divergence of author's opinions seems to spring from differences in the conditions of sprouting and lack of attention to temperature regime, humidity, illumination, concentration of soil solutions and growth processes. The interrelation of processes occurring in wintering plants is to be conceived in the following manner: the action of external factors, among them lower temperature,—the lowered activity of the respiratory oxidation-reduction processes depending on the degree of winter-hardiness,—the retarded division and expansion of cells, lowered rate of growth,—the relatively

accelerated processes of cell differentiation, their cutinization, lignification, the formation of external and internal «frameworks» setting a limit to further growth of cells, internodes and leaves,—accumulation of unutilized products of assimilation, dessication, intensification of the osmotic pressure,—frost resistance.

Reduction of the internode and leaf blades due to the influence of the factors enumerated above is a general phenomenon for all the higher plants differing only in «norms of reaction». Winter-hardiness of the most resistant trees is based on rapidity of formation of wintering buds, covered with a mass of tightly overlapping «scales». The scales are also leaves, but formed under conditions of intense illumination, low temperature and lack of moisture due to the cutting off of water ducts and relatively high evaporation. Parallel with the reduction of leaves to scales goes the shortening of the internodes. The end of the shoot assumes the form of a bud, in which the growing point is shielded by a mass of scale-like casings.

The earlier the beginning of the transformation of true leaves into scales, the greater number of them will form before winter and the more protected will be the growing point against frosts. The sooner the growth of the internodes situated below the buds ceases, the more time remains for their ripening—the formation and drying of wood and cork—and so the greater the frost resistance of the internodes.

The winter-hardy perennials respond sensitively to factors of external influence—light, cold, lack of water—and start early the formation of wintering buds; in the southern, non-hardy ones, this process is delayed till late autumn, while in tropical and annual plants wintering buds usually are not formed at all, the buds reamain the whole time «open» and give continually new leaves of the same type.

Within any species (apples, grapes, citrus fruits) there are undoubtedly variations in the time of bud scale formation and the opening of the buds in the spring. It is the business of plant breeding, to ascertain these variations, to choose those most sensitively responding to the action of the «harbingers of coming winter», to pass on other economic qualities and to multiply the better ones.

II. EARLINESS

Different varieties of spring wheats, when grown under identical conditions give, already in their very first stages, different indices of growth. Under identical conditions of growth, the quick-ripening varieties are characterized by a greater size and weight of the first elements (Table 4).

Variations within varieties are shown in Table 5 for Novinka, *Erythrospermum* 0341 and *Milturum* 0321.

Within varieties there is possible a selection of plants of quicker or slower ripening. This fact ought to be taken into account in selecting quick-ripening forms for northern regions.

The possibility of the extension of the rule of correspondence between earliness and size of different elements of seedlings to other crops (tomatoes, squashes and others) is a matter for further investigation. In the author's opinion, however, there is no doubt that every plant character that is to be found fully expressed in the process of attaining «economic» ripeness, may also be found in the form of one or another character in the first stages of the development of that plant. The morphologist, the anatomist, the cytologist, the physiologist must discover these characters and pass them on to the plant breeder so that desirable forms may be chosen, combined and propagated.

Table 4

Grown during the Period March 3 to April 1 in Diffused Daylight at Temperatures from 10 to 12° C

Nos	Variety of soft wheat	Weight of 100 seeds in g	Degree of earliness (after Vavilov)	Length of 1st true leaf in cm	Length of 1st internode in cm
	A. Spring wheats				
1	Novinka	3.54	4	14.04	5.62
2	Grekum 0289	4.10	3+	12.86	5.43
3	*Erythrospermum*	2.57	3	11.87	4.66
4	Marquis	3.14	2	10.43	4.02
5	*Milturum* 0321	2.42	1	9.34	3.52
	B. Winter wheat				
6	*Lutescens* 0329	3.60	—	7.77	2.59

Table 5

Nos	Novinka		*Erythrospermum* 0341		*Milturum* 0321	
	Length of 1st true leaf in cm	Length of 1st internode in cm	Length of 1st true leaf in cm	Length of 1st internode in cm	Length of 1st true leaf in cm	Length of 1st internode in cm
1	15.1	5.4	13.0	4.5	9.8	3.6
2	13.4	5.5	12.8	4.1	9.8	3.2
3	14.0	7.1	11.8	4.4	9.9	3.5
4	13.4	6.0	11.0	4.6	9.5	3.8
5	12.7	5.2	12.7	4.8	9.9	3.5
6	11.5	5.4	**13.5**	5.1	9.5	3.8
7	13.3	5.7	11.2	4.1	8.8	3.5
8	**11.5**	5.8	10.8	4.4	7.7	3.4
9	14.1	5.6	10.9	4.3	10.3	3.6
10	14.5	6.0	11.2	5.0	9.9	3.5
11	16.0	5.9	12.5	4.8	9.0	3.4
12	13.1	5.2	11.5	4.9	9.7	3.8
13	14.7	6.2	11.3	4.8	10.1	3.5
14	12.9	5.5	12.2	5.2	9.7	3.6
15	14.1	5.5	11.0	4.4	9.3	3.4
16	**16.0**	6.0	12.4	4.4	**10.6**	4.1
17	13.9	5.8	13.1	4.9	10.3	4.0
18	14.0	4.9	13.1	4.9	9.5	3.3
19	15.7	5.9	10.9	4.7	8.1	3.2
20	13.9	5.6	12.6	4.6	9.8	3.8
21	15.1	5.2	**9.9**	4.5	8.1	3.7
22	14.0	5.0	12.0	4.7	10.0	3.2
23	15.9	5.6	11.2	4.7	8.8	3.3
24	14.7	4.9	11.5	4.6	8.2	3.4
25	13.3	6.0	12.8	5.0	**7.3**	3.3
Average	14.04	5.64	11.87	4.66	9.34	3.52

The investigation was carried on with the participation of L. F. Dmitrova-Kolomyceva and E. Kolomycev.

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